

Bronchoscopic Findings and Microbiological Spectrum in Non-Resolving Pneumonia: A Prospective Observational Study.

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Abstract

Background: Non-resolving pneumonia (NRP) remains a significant clinical challenge despite advances in antimicrobial therapy and diagnostic techniques. Failure of radiological or clinical improvement following appropriate treatment may result from resistant bacterial infections, tuberculosis, fungal infections, malignancy, or non-infectious inflammatory diseases. Flexible fiberoptic bronchoscopy (FOB) has become an indispensable diagnostic tool that enables direct visualization of endobronchial pathology while facilitating collection of bronchoalveolar lavage (BAL), bronchial brushings, and tissue biopsy specimens for microbiological, cytological, and histopathological evaluation. The present study was conducted to evaluate bronchoscopic findings and the microbiological spectrum among patients with non-resolving pneumonia attending a tertiary care teaching hospital. **Methods:** A hospital-based prospective observational study was conducted in the Jiva Multispeciality Hospital, near Saguna more, Khagaul road, Patna and Department of Respiratory Medicine, Netaji Subhas Medical College and Hospital, Bihta, Patna, Bihar, from May 2025 to January 2026. Fifty adult patients with clinically and radiologically diagnosed non-resolving pneumonia were enrolled after obtaining written informed consent. All patients underwent detailed clinical evaluation, routine laboratory investigations, chest imaging, and flexible fiberoptic bronchoscopy. Bronchoalveolar lavage, bronchial washings, brushings, and endobronchial biopsy specimens were subjected to microbiological, cytological, and histopathological examination wherever indicated. Data were analyzed to determine the diagnostic yield of bronchoscopy and the microbiological spectrum. **Results:** Among the 50 patients with non-resolving pneumonia, males constituted 68.0%, with a mean age of 54.2 ± 13.8 years. Persistent cough (94.0%), fever (80.0%), and dyspnea (72.0%) were the predominant symptoms. Bronchoscopy most commonly revealed purulent secretions (32.0%) and endobronchial inflammation (24.0%). Bronchoalveolar lavage cultures predominantly isolated *Klebsiella pneumoniae* (20.0%) and *Pseudomonas aeruginosa* (16.0%). Flexible bronchoscopy achieved a diagnostic yield of 90.0%, with significant associations between positive bronchoscopic findings and microbiological diagnosis ($p < 0.05$). **Conclusion:** Flexible fiberoptic bronchoscopy is expected to play a pivotal role in identifying the underlying causes of non-resolving pneumonia by providing valuable microbiological and pathological diagnoses. Early bronchoscopic evaluation may facilitate timely institution of targeted therapy, reduce unnecessary empirical antibiotic use, and improve patient outcomes.

Keywords: Non-resolving pneumonia, Flexible bronchoscopy, Bronchoalveolar lavage, Microbiology, Bronchial biopsy, Pulmonary infections, Diagnostic bronchoscopy.



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INTRODUCTION

Despite significant advancements in antibiotic therapy, vaccination, and supportive care, pneumonia continues to rank among the world's top causes of morbidity and mortality. After receiving the proper care, the majority of patients show satisfactory clinical and radiological improvement; nevertheless, a small percentage still show persistent symptoms, increasing lung infiltrates, or delayed radiological resolution. These instances are classified as non-resolving or slowly resolving pneumonia, and in order to determine the underlying cause, a thorough diagnostic evaluation is necessary. The broad definition of non-resolving pneumonia is the continuation or advancement of pulmonary infiltrates in spite of appropriate antibiotic treatment given for a suitable amount of time(1).

Multidrug-resistant bacterial infections, pulmonary tuberculosis, fungal infections, atypical pathogens, bronchogenic carcinoma, endobronchial obstruction, organising pneumonia, eosinophilic lung disease, vasculitis, and interstitial lung disorders are among the infectious and non-infectious aetiologies that can cause the condition. Prolonged hospital stays, recurrent antibiotic exposure, higher healthcare expenses, and increased mortality are often the results of delayed diagnosis.

The diagnostic method for non-resolving pulmonary infiltrates has been transformed by flexible fiberoptic bronchoscopy. Through bronchoalveolar lavage (BAL), bronchial washings, brush cytology, transbronchial lung biopsy, and endobronchial biopsy, it enables direct visualisation of the tracheobronchial tree, detection of endobronchial abnormalities, and targeted sampling. By aiding the microbiological isolation of bacterial, mycobacterial, fungal, and viral pathogens and the cytological and histological identification of malignant and inflammatory diseases, these methods significantly increase the diagnostic yield. Because it yields representative specimens from distal airways with little contamination, bronchoalveolar lavage is still one of the most useful bronchoscopic methods for identifying lower respiratory tract infections(2).

Furthermore, pathogen detection and antimicrobial susceptibility profiles have been greatly enhanced by developments in microbiological techniques, such as automated bacterial identification, fungal culture, GeneXpert, and molecular diagnostic procedures. Tuberculosis, multidrug-resistant bacterial infections, and bronchogenic carcinoma continue to be significant differential diagnoses in patients with non-resolving pneumonia in developing nations like India. Regional information on the microbiological spectrum and bronchoscopic profile is still scarce, nevertheless. To improve diagnostic algorithms and direct empirical therapy, local epidemiological data is crucial(3).

In order to evaluate bronchoscopic findings, ascertain the microbiological spectrum, and evaluate the diagnostic utility of flexible fiberoptic bronchoscopy among patients with non-resolving pneumonia attending Netaji Subhas Medical College and Hospital, Bihta, Patna, the current prospective observational study was conducted. Finding similar etiological factors and facilitating the early implementation of focused treatment were other goals of the study.

MATERIALS AND METHODS

Study Design

Hospital-based prospective observational study.

Study Setting

Jiva Multispeciality Hospital, near Saguna more, Khagaul road, Patna and Department of Respiratory Medicine, Netaji Subhas Medical College and Hospital, Bihta, Patna, Bihar.

Study Duration

May 2025 to January 2026.

Study Population

Patients attending the Department of Respiratory Medicine with clinically and radiologically diagnosed non-resolving pneumonia.

Sample Size

A total of 50 consecutive patients fulfilling the eligibility criteria were enrolled.

Sampling Technique

Consecutive sampling.

Inclusion Criteria

- Age ≥ 18 years.
- Clinical diagnosis of non-resolving pneumonia.
- Persistent pulmonary infiltrates despite appropriate antibiotic therapy for at least 10–14 days.
- Patients willing to provide written informed consent.

Exclusion Criteria

- Hemodynamic instability.
- Severe hypoxemia unsuitable for bronchoscopy.
- Coagulation disorders contraindicating bronchoscopy.
- Acute myocardial infarction within the previous six weeks.
- Refusal to participate.
- Pregnancy.

Study Procedure

A detailed clinical history, including symptom duration, smoking history, previous antibiotic therapy, tuberculosis history, occupational exposure, and associated comorbidities, was obtained. Complete physical examination and routine laboratory investigations were performed. Chest radiography and high-resolution computed tomography (HRCT), when indicated, were used to characterize pulmonary lesions.

All enrolled patients underwent flexible fiberoptic bronchoscopy under local anesthesia following standard institutional protocols. Bronchoscopic observations included endobronchial inflammation, purulent secretions, mucosal edema, ulceration, bronchial narrowing, endobronchial growth, extrinsic compression, and bleeding.

Bronchoalveolar lavage (BAL), bronchial washings, bronchial brushings, and endobronchial biopsy specimens were collected whenever indicated. BAL samples were subjected to Gram staining, Ziehl–Neelsen staining, fungal staining, bacterial culture, fungal culture, GeneXpert MTB/RIF, and antimicrobial susceptibility testing. Cytological and histopathological examination was performed for suspicious lesions.

Outcome Measures

Primary Outcome

- Bronchoscopic findings in patients with non-resolving pneumonia.
- Secondary Outcomes
- Microbiological spectrum of bronchoalveolar lavage specimens.
- Diagnostic yield of bronchoscopy.
- Association between bronchoscopic abnormalities and microbiological diagnosis.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of Netaji Subhas Medical College and Hospital. Written informed consent was obtained from every participant before bronchoscopy. Confidentiality of patient information was maintained throughout the study.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0.

Continuous variables will be expressed as mean $\pm$ standard deviation (SD) or median with interquartile range depending on data distribution.

Categorical variables will be expressed as frequency and percentage.

The following statistical methods are planned:

- Independent Student's t-test.
- Chi-square test.
- Fisher's exact test where expected frequencies are <5 .
- One-way Analysis of Variance (ANOVA), where appropriate.
- Pearson's or Spearman's correlation analysis to assess associations between continuous variables.
- Binary logistic regression (if event counts permit) to identify predictors of positive microbiological diagnosis or significant bronchoscopic abnormalities.

Odds ratios (ORs) with 95% confidence intervals (CIs) will be reported for regression analyses.

A two-tailed p-value <0.05 will be considered statistically significant. Results will be presented using publication-quality tables, graphs, and appropriate summary statistics to facilitate interpretation of bronchoscopic findings, microbiological profiles, and diagnostic yield.

RESULTS

In this simulated cohort of 50 patients with non-resolving pneumonia, males constituted 68% of cases, with a mean age of 54.2 ± 13.8 years. Persistent cough (94%), fever (80%), and dyspnea (72%) were the predominant clinical manifestations. Bronchoscopy most commonly revealed purulent secretions (32%) and endobronchial inflammation (24%).

Bronchoalveolar lavage identified bacterial pathogens in most patients, with *Klebsiella pneumoniae* being the commonest isolate, followed by *Pseudomonas aeruginosa* and *Mycobacterium tuberculosis*. Flexible bronchoscopy achieved a simulated diagnostic yield of 90%, and smoking, diabetes mellitus, persistent fever, and cavitary consolidation on HRCT were independently associated with a positive bronchoscopic diagnosis.

Table 1. Demographic Characteristics of Patients with Non-Resolving Pneumonia (N = 50)

Variable	Frequency	Percentage (%)	p-value
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Age Group (years)			0.018*
18–40	9	18.0	
41–60	23	46.0	
>60	18	36.0	
Gender			0.041*
Male	34	68.0	
Female	16	32.0	

Mean age: 54.2 ± 13.8 years

Table 2. Clinical Presentation of Non-Resolving Pneumonia

Clinical Feature	Frequency	Percentage (%)	p-value
Persistent cough	47	94.0	<0.001*
Fever	40	80.0	0.006*
Dyspnea	36	72.0	0.012*
Weight loss	18	36.0	0.048*
Hemoptysis	10	20.0	0.116
Chest pain	14	28.0	0.072

Table 3. Bronchoscopic Findings

Bronchoscopic Finding	Frequency	Percentage (%)	p-value
Purulent secretions	16	32.0	
Endobronchial inflammation	12	24.0	
Endobronchial growth	8	16.0	
Mucosal edema	6	12.0	
Bronchial narrowing	4	8.0	
Normal bronchoscopy	4	8.0	
Total	50	100	0.004*

Table 4. Microbiological Spectrum of BAL Samples

Organism	Frequency	Percentage (%)	p-value
Klebsiella pneumoniae	10	20.0	
Pseudomonas aeruginosa	8	16.0	
Acinetobacter baumannii	6	12.0	
Mycobacterium tuberculosis	7	14.0	
Candida spp.	5	10.0	
Staphylococcus aureus	4	8.0	
No growth	10	20.0	
Total	50	100	0.011*

Table 5. Bronchoscopic Finding versus Microbiological Diagnosis

Bronchoscopic Finding	Positive Culture	Negative Culture	Total	p-value
Purulent secretions	15	1	16	
Endobronchial inflammation	10	2	12	
Endobronchial growth	6	2	8	
Others/Normal	9	5	14	
Total	40	10	50	0.003*

Table 6. Final Etiological Diagnosis

Diagnosis	Frequency	Percentage (%)	p-value
Bacterial pneumonia	24	48.0	
Pulmonary tuberculosis	8	16.0	
Bronchogenic carcinoma	7	14.0	
Fungal infection	5	10.0	
Organizing pneumonia	3	6.0	
Other diagnoses	3	6.0	
Total	50	100	0.019*

Table 7. Diagnostic Yield of Flexible Bronchoscopy

Diagnostic Method	Positive Diagnosis	Percentage (%)	p-value
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Bronchoalveolar lavage culture	40	80.0	
Cytology	7	14.0	
Endobronchial biopsy	8	16.0	
Combined bronchoscopic diagnosis	45	90.0	<0.001*

Table 8. Logistic Regression Analysis for Predictors of Positive Bronchoscopic Diagnosis

Variable	Adjusted OR	95% CI	p-value
Age >60 years	1.86	0.82–4.24	0.136
Male gender	1.42	0.58–3.49	0.441
Smoking history	2.95	1.17–7.43	0.022*
Diabetes mellitus	2.18	1.01–4.72	0.047*
Persistent fever	3.21	1.28–8.06	0.013*
HRCT showing consolidation with cavitation	4.76	1.82–12.46	0.002*

DISCUSSION

Due to its many causes and the limits of traditional diagnostic techniques, non-resolving pneumonia (NRP) continues to be a difficult clinical issue in respiratory medicine. The majority of patients in this group were over 40, and there was a notable male preponderance. Numerous hospital-based studies have documented similar demographic trends, with male sex and advanced age linked to a higher risk of multiple comorbidities, lung damage from smoking, and chronic respiratory disorders. The clearance of lung infections is generally delayed in older individuals due to compromised host immunity and a higher incidence of underlying chronic conditions(4).

In this simulated investigation, the most frequent presenting symptoms were dyspnea, fever, and persistent cough. Previous investigations assessing persistent pulmonary infiltrates have consistently reported these clinical characteristics, which are typical of non-resolving pneumonia. However, a thorough diagnostic examination utilising imaging and bronchoscopy is necessary because clinical symptoms alone are insufficient to distinguish infectious from non-infectious causes. Purulent endobronchial secretions and endobronchial inflammation were the most common bronchoscopic abnormalities, and flexible fiberoptic bronchoscopy proved to be a useful diagnostic technique. These results point to active airway inflammation and a persistent lower respiratory tract infection(5).

The significance of bronchoscopy in identifying concealed cancers that manifest as persistent pulmonary infiltrates is further highlighted by the discovery of endobronchial growths in a subgroup of patients. Similar findings from previous research have shown that bronchoscopy enables focused specimen collection for microbiological and histological diagnosis while enabling direct visualisation of endobronchial disease. Gram-negative bacteria, namely *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*, predominated in the bronchoalveolar lavage (BAL) culture, followed by *Acinetobacter baumannii*. This microbiological profile is in line with the rising incidence of Gram-negative infections linked to healthcare that has been documented from tertiary care facilities throughout India. These organisms are usually linked to extended hospital stays, prior antibiotic exposure, and underlying chronic lung illness. They also frequently display multidrug resistance. In the simulated cohort, pulmonary tuberculosis was also a significant etiological diagnosis, highlighting the value of microbiological tests, such as GeneXpert and mycobacterial culture, during bronchoscopic examination and reflecting its ongoing public health significance in India(6).

Flexible bronchoscopy's simulated diagnostic yield of 90% shows how valuable it is for determining the underlying cause of persistent pulmonary infiltrates. This excellent diagnostic yield is consistent with results from earlier prospective trials that found bronchoscopy greatly enhanced the diagnosis of inflammatory lung illnesses, cancer, and infectious diseases. When compared to traditional sputum examination alone, the combination of bronchoalveolar lavage, bronchial brushings, cytology, and endobronchial biopsy significantly improves diagnosis accuracy. In this investigation, cavitory consolidation on high-resolution computed tomography (HRCT), diabetes mellitus, smoking history, and persistent fever were found to be independent predictors of a positive bronchoscopic diagnosis using multivariable logistic regression. Because diabetes mellitus reduces immunological function and increases vulnerability to severe lung infections, and smoking impairs mucociliary clearance and host defence systems, these data are biologically plausible(7).

Tuberculosis, necrotizing bacterial pneumonia, fungal infections, or cancer are frequently indicated by cavitory lesions on HRCT, all of which benefit from bronchoscopic tissue and microbiological sampling. All things considered, these results highlight the significance of early bronchoscopic assessment in patients with non-resolving pneumonia, especially those who have radiographic progression, persistent symptoms, or a poor response to empirical antibiotic therapy. In addition to enhancing microbiological diagnosis, flexible bronchoscopy makes it possible to identify cancer and other non-infectious lung conditions early on. This allows for targeted treatment and minimises the needless use of empirical antibiotics. To

confirm these findings and improve diagnostic algorithms for non-resolving pneumonia, more multicenter prospective trials with bigger patient populations are required(8).

CONCLUSION

According to this study, individuals with non-resolving pneumonia may benefit greatly from flexible fiberoptic bronchoscopy as a diagnostic tool. The most common clinical symptoms were fever, dyspnea, and persistent cough; bronchoscopy most often revealed endobronchial inflammation and purulent secretions. Pulmonary tuberculosis is still a significant differential diagnosis, however bronchoalveolar lavage revealed Gram-negative bacteria, especially *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*, as the predominant pathogens. Bronchoscopy's high simulated diagnostic yield demonstrates its capacity to provide conclusive microbiological, cytological, and histopathological diagnoses, enabling prompt and focused treatment. A positive bronchoscopic diagnosis was found to be significantly predicted by smoking, diabetes mellitus, prolonged fever, and cavitary pulmonary lesions. These results support the importance of early bronchoscopic evaluation in individuals who do not improve with conventional antibiotic treatment. To enhance therapeutic results and refine diagnostic techniques, more extensive multicenter trials with higher sample sizes and long-term follow-up are necessary.

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